WHAT IS CLAIMED IS:

1. A catalyst degradation determining method for use with an emission control apparatus of an internal combustion engine that includes: a catalyst disposed in an exhaust passage of the internal combustion engine, and a downstream-of-catalyst air-fuel ratio sensor disposed in the exhaust passage downstream of the catalyst, the method comprising the steps of:

acquiring an oxidizing-reducing capability index value that changes in accordance with a degree of an oxidizing-reducing capability of the catalyst;

controlling an upstream-of-catalyst air-fuel ratio occurring upstream of the catalyst to an air-fuel ratio that is lean of a stoichiometric air-fuel ratio so that the catalyst stores oxygen in the catalyst up to a maximum storage amount of oxygen;

then controlling the upstream-of-catalyst air-fuel ratio to a rich air-fuel ratio that is rich of the stoichiometric air-fuel ratio and that has a value that is determined in accordance with the oxidizing-reducing capability index value, until a time point when an output of the downstream-of-catalyst air-fuel ratio sensor indicates an air-fuel ratio that is rich of the stoichiometric air-fuel ratio;

estimating a maximum oxygen storage amount of the catalyst by taking into account the value of the rich air-fuel ratio to which the upstream-of-catalyst air-fuel ratio was controlled; and

determining whether the catalyst has degraded based on the estimated maximum oxygen storage amount of the catalyst.

2. The catalyst degradation determining method according to claim 1, wherein:

the emission control apparatus of the internal combustion engine with which the catalyst degradation determining method is used includes an upstream-of-catalyst air-fuel ratio sensor disposed in the exhaust passage upstream of the catalyst, and an upstream-of-catalyst air-fuel ratio sensor abnormality detector that detects an abnormality of the upstream-of-catalyst air-fuel ratio sensor,

the maximum oxygen storage amount of the catalyst is estimated based on an output of the upstream-of-catalyst air-fuel ratio sensor,

a determination that the catalyst has degraded is prohibited in a case where the catalyst is in a state in which it is to be determined that the catalyst has degraded based on the estimated maximum oxygen storage amount, and where an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, and

it is determined that the catalyst has not degraded regardless of whether an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, in a case where the catalyst is in a state in which it is determined that the catalyst has not degraded based on the estimated maximum oxygen storage amount.

3. A catalyst degradation determining method for use with an emission control apparatus of an internal combustion engine that includes: a first catalyst disposed in an exhaust passage of the internal combustion engine, a downstream-of-first catalyst air-fuel ratio sensor disposed in the exhaust passage downstream of the first catalyst, a second catalyst disposed in the exhaust passage downstream of the downstream-of-first catalyst air-fuel ratio sensor, and a downstream-of-second catalyst air-fuel ratio sensor disposed in the exhaust passage downstream of the second catalyst, the method comprising the steps of:

acquiring an oxidizing-reducing capability index value that changes in accordance with at least one of a degree of an oxidizing-reducing capability of the first catalyst and a degree of an oxidizing-reducing capability of the second catalyst;

controlling an upstream-of-first catalyst air-fuel ratio occurring upstream of the first catalyst to an air-fuel ratio that is lean of a stoichiometric air-fuel ratio so that the first catalyst stores oxygen in the first catalyst up to a maximum oxygen storage amount of the first catalyst and the second catalyst stores oxygen in the second catalyst up to a maximum oxygen storage amount of the second catalyst;

then controlling the upstream-of-first catalyst air-fuel ratio to a first rich air-fuel ratio that is rich of the stoichiometric air-fuel ratio, until a time point when an output of the downstream-of-first catalyst air-fuel ratio sensor indicates an air-fuel ratio that is rich of the stoichiometric air-fuel ratio;

then controlling the upstream-of-first catalyst air-fuel ratio to a second rich air-fuel ratio that is rich of the stoichiometric air-fuel ratio and that has a value that is determined in accordance with the oxidizing-reducing capability index value, until a time point when an output of the downstream-of-second catalyst air-fuel ratio sensor indicates an air-fuel ratio that is rich of the stoichiometric air-fuel ratio;

estimating a maximum oxygen storage amount of the first catalyst by taking into account the first rich air-fuel ratio to which the upstream-of-first catalyst air-fuel ratio was controlled;

estimating a maximum oxygen storage amount of the second catalyst by taking into account the value of the second rich air-fuel ratio to which the upstream-of-first catalyst air-fuel ratio was controlled; and

determining whether at least one of the first catalyst, the second catalyst and a catalyst device that includes the first catalyst and the second catalyst has degraded based on at least one of the estimated maximum oxygen storage of the first catalyst and the estimated maximum oxygen storage of the second catalyst.

4. The catalyst degradation determining method according to claim 3, wherein the first rich air-fuel ratio is richer than the second rich air-fuel ratio.

5. The catalyst degradation determining method according to claim 3, wherein:

the emission control apparatus of the internal combustion engine with which the catalyst degradation determining method is used includes an upstream-of-catalyst air-fuel ratio sensor disposed in the exhaust passage upstream of the first catalyst, and an upstream-of-catalyst air-fuel ratio sensor abnormality detector that detects an abnormality of the upstream-of-catalyst air-fuel ratio sensor,

the maximum oxygen storage amount of the first catalyst and the maximum oxygen storage amount of the second catalyst are estimated based on an output of the upstream-of-catalyst air-fuel ratio sensor,

a determination that at least one of the first and second catalysts has degraded is prohibited in a case where the at least one of the first and second catalysts is in a state in which it is to be determined that the at least one of the first and second catalysts has degraded based on at least one of the first and second catalyst estimated maximum oxygen storage amounts, and where an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, and

it is determined that the at least one of the first and second catalysts has not degraded regardless of whether an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, in a case where the at least one of the first and second catalysts is in a state in which it is to be determined that the at least one of the first and second catalysts has not degraded based on at least one of the first and second catalyst estimated maximum oxygen storage amounts.

6. A catalyst degradation determining method for use with an emission control apparatus of an internal combustion engine that includes: a catalyst disposed in an exhaust passage of the internal combustion engine, and a downstream-of-catalyst air-fuel ratio sensor disposed in the exhaust passage downstream of the catalyst, the method comprising the steps of:

acquiring an oxidizing-reducing capability index value that changes in accordance with a degree of an oxidizing-reducing capability of the catalyst;

controlling an upstream-of-catalyst air-fuel ratio occurring upstream of the catalyst to an air-fuel ratio that is rich of a stoichiometric air-fuel ratio so that the catalyst completely releases oxygen stored in the catalyst;

then controlling the upstream-of-catalyst air-fuel ratio to a lean air-fuel ratio that is lean of the stoichiometric air-fuel ratio and that has a value that is determined in accordance with the oxidizing-reducing capability index value, until a time point when an output of the downstream-of-catalyst air-fuel ratio sensor indicates an air-fuel ratio that is lean of the stoichiometric air-fuel ratio;

estimating a maximum oxygen storage amount of the catalyst by taking into account the value of the lean air-fuel ratio to which the upstream-of-catalyst air-fuel ratio was controlled; and

determining whether the catalyst has degraded based on the estimated maximum oxygen storage amount of the catalyst.

7. The catalyst degradation determining method according to claim 6, wherein:

the emission control apparatus of the internal combustion engine with which the catalyst degradation determining method is used includes an upstream-of-catalyst air-fuel ratio sensor disposed in the exhaust passage upstream of the catalyst, and an upstream-of-catalyst air-fuel ratio sensor abnormality detector that detects an abnormality of the upstream-of-catalyst air-fuel ratio sensor,

the maximum oxygen storage amount of the catalyst is estimated based on an output of the upstream-of-catalyst air-fuel ratio sensor,

a determination that the catalyst has degraded is prohibited in a case where the catalyst is in a state in which it is to be determined that the catalyst has degraded based on the estimated maximum oxygen storage amount, and where an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, and

it is determined that the catalyst has not degraded regardless of whether an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, in a case where the catalyst is in a state in which it is determined that the catalyst has not degraded based on the estimated maximum oxygen storage amount.

8. A catalyst degradation determining method for use with an emission control apparatus of an internal combustion engine that includes: a first catalyst disposed in an exhaust passage of the internal combustion engine, a downstream-of-first catalyst air-fuel ratio sensor disposed in the exhaust passage downstream of the first catalyst, a second catalyst disposed in the exhaust passage downstream of the downstream-of-first catalyst air-

fuel ratio sensor, and a downstream-of-second catalyst air-fuel ratio sensor disposed in the exhaust passage downstream of the second catalyst, the method comprising the steps of:

acquiring an oxidizing-reducing capability index value that changes in accordance with at least one of a degree of an oxidizing-reducing capability of the first catalyst and a degree of an oxidizing-reducing capability of the second catalyst;

controlling an upstream-of-first catalyst air-fuel ratio occurring upstream of the first catalyst to an air-fuel ratio that is rich of a stoichiometric air-fuel ratio so that the first catalyst completely releases oxygen stored in the first catalyst and the second catalyst completely releases oxygen stored in the second catalyst;

then controlling the upstream-of-first catalyst air-fuel ratio to a first lean air-fuel ratio that is lean of the stoichiometric air-fuel ratio, until a time point when an output of the downstream-of-first catalyst air-fuel ratio sensor indicates an air-fuel ratio that is lean of the stoichiometric air-fuel ratio;

then controlling the upstream-of-first catalyst air-fuel ratio to a second lean air-fuel ratio that is lean of the stoichiometric air-fuel ratio and that has a value that is determined in accordance with the oxidizing-reducing capability index value, until a time point when an output of the downstream-of-second catalyst air-fuel ratio sensor indicates an air-fuel ratio that is lean of the stoichiometric air-fuel ratio;

estimating a maximum oxygen storage amount of the first catalyst by taking into account the first lean air-fuel ratio to which the upstream-of-first catalyst air-fuel ratio was controlled;

estimating a maximum oxygen storage amount of the second catalyst by taking into account the value of the second lean air-fuel ratio to which the upstream-of-first catalyst air-fuel ratio was controlled; and

determining whether at least one of the first catalyst, the second catalyst and a catalyst device that includes the first catalyst and the second catalyst has degraded based on at least one of the estimated maximum oxygen storage amount of the first catalyst and the estimated maximum oxygen storage amount of the second catalyst.

9. The catalyst degradation determining method according to claim 8, wherein the first lean air-fuel ratio is leaner than the second lean air-fuel ratio.

10. The catalyst degradation determining method according to claim 8, wherein:

the emission control apparatus of the internal combustion engine with which the catalyst degradation determining method is used includes an upstream-of-catalyst air-fuel ratio sensor disposed in the exhaust passage upstream of the first catalyst, and an upstream-

of-catalyst air-fuel ratio sensor abnormality detector that detects an abnormality of the upstream-of-catalyst air-fuel ratio sensor,

the maximum oxygen storage amount of the first catalyst and the maximum oxygen storage amount of the second catalyst are estimated based on an output of the upstream-of-catalyst air-fuel ratio sensor,

a determination that at least one of the first and second catalysts has degraded is prohibited in a case where the at least one of the first and second catalysts is in a state in which it is to be determined that the at least one of the first and second catalysts has degraded based on at least one of the first and second catalyst estimated maximum oxygen storage amounts, and where an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, and

it is determined that the at least one of the first and second catalysts has not degraded regardless of whether an abnormality of the upstream-of-catalyst air-fuel ratio sensor has been detected, in a case where the at least one of the first and second catalysts is in a state in which it is determined that the at least one of the first and second catalysts has not degraded based on at least one of the first and second catalyst estimated maximum oxygen storage amounts.